Open Systems Networking

ARCNETPLUS™

A statement on Datapoint's advanced
Local Area Networking technology

THE EVOLUTION OF A LAN

The past two decades of new technology design and implementation have been a process filled with the gratification of completion followed by a rapid replacement cycle. New and better ways to accomplish the same objectives are being discovered daily. The Local Area Network (LAN) is one area where this cycle has been accomplished more slowly than most. In the late 1970's both ARCNET and Ethernet found commercial success as they were introduced into selective marketplaces which were slowly accepting the transition from centralized computing to distributed, networked systems. By 1991 these two "ancient" technologies accounted for almost sixty-seven percent of installed LAN connections.

INTEGRATION AND COST INVESTMENT

The staying power of these pioneering technologies is quite remarkable considering faster products have been designed and made commercially available in the intervening years. The continued commercial success of these initial products can be attributed to the fact that the basic concepts have remained unchanged over the years and there has been continued technical investment in both products to retain and expand their viability in the marketplace. Most of this investment has been used to increase product integration at the building block level, thereby reducing the costs of products incorporating the improvements. A second major contributor has been the proliferation of wiring systems supported, including coax, fiber, and Unshielded Twisted Pair (UTP) cable.

PERFORMANCE INVESTMENT

Until 1992 the only commercially successful LAN to undergo a performance enhancment occurred through the release of the IBM 16 Mbit

Token Ring Network (TRN/16). The original 4 Mbit Token Ring Network (TRN/4) was introduced in the marketplace as an alternative to ARCNET and Ethernet, but was never widely accepted. The lack of industry interest led the TRN developers to create a solution which raised the network bit rate performance from 4 million bits per second to 16 million bits per second.

With the introduction of the 16 Mbit Token Ring Network came the decision to obsolete the original 4 Mbit product. This determination was necessary because of the TRN signalling architecture whereby each data packet has to be processed by every node on the network. All the nodes can only receive and send data at exactly the same rate — therefore, the slowest node defines the maximum bit rate performance of the entire network.

The only means available to improve LAN bit rate performance prior to 1992 was based on a replacement and obsolescence strategy. Discussions regarding a similar strategy for Ethernet surface in the trade press periodically, but the potential problems for such a large installed base appear to be insurmountable. Ethernet's success and marketshare appear to have frozen the data rate performance at 10 Mbits per second.

ANOTHER APPROACH TO MULTI-SPEED TECHNOLOGY

When ARCNET performance improvements were first discussed, no consideration was given to a replacement or obsolescence strategy. The power of ARCNET in the commercial marketplace lies in the free range of the technology components and the ability to interchange products and components between suppliers.

The original designers of the ARCNET protocol, Datapoint Corporation, were committed to a development strategy of upward compatibility for all products. Under the guidance of the ARCNET Trade Association (ATA), any performance improvement to ARCNET would be acceptable only if the original products would continue to interchange data and share networks with the enhanced products.

ARCNETPLUS

Within these guidelines the concept of ARCNETPLUS was born — a faster version of ARCNET capable of total compatibility with previous ARCNET products.

ARCNETPLUS is a 20 million bits per second (Mbps) LAN which has been designed and implemented to offer performance and service to meet the applications requirements of the 1990s. Prime characteristics of these applications include:

- large command files with a great deal of programming space and high memory utilization;
- frequent data access and storage requirements;
- larger networks than ever before and more competition for the server;
- graphics on the desktop and images in the applications; and
- higher overhead and more flexible standard protocols.

Combined, all of these elements create a network-level bandwidth requirement which greatly surpasses the applications needs of the last 15 years. Incorporating such large data and application traffic — as well as a multitude of small messages — requires a network designed to optimize the small messages and also support large information blocks. ARCNETPLUS, a high-integrity, high-performance LAN, is the first product

which combines multi-speed economic benefits with record-setting performance.

The unique features and performance of ARCNETPLUS reflect a systems solution for the use of LANs based on the experience and commercial success of ARCNET.

The new ARCNETPLUS features are enhancements which have evolved through an understanding of how a properly designed and implemented network can become a virtual Information Technology tool for an end user.

ARCNET's Success in the Marketplace

The success of the ARCNET technology in the marketplace can be measured in a variety of ways. There is the obvious commercial success — nearly four million nodes shipped to date. (Figure 1) Then, there is ARCNET's economy and reliability, the reasons customers buy and suppliers sell ARCNET. Both customers and suppliers are interested in customer satisfaction and future implications relative to business systems. Since its 1977 introduction, ARCNET has provided users with a low-cost economic solution, and long-term benefits, such as ease of expansion and configuration flexibility.

Another reason for the wide acceptance of ARCNET as a primary LAN solution is the availability of ARCNET-compatible products from a variety of sources. This is a direct result of the fact that the primary ARCNET design elements are encapsulated as elemental building blocks, guaranteeing compatibility at the network level. This concept has enabled systems component manufacturers to concentrate on opportunities for performance and feature enhancements without jeopardizing the integrity and compatibility of future additions which could be sourced from an alternative supplier.
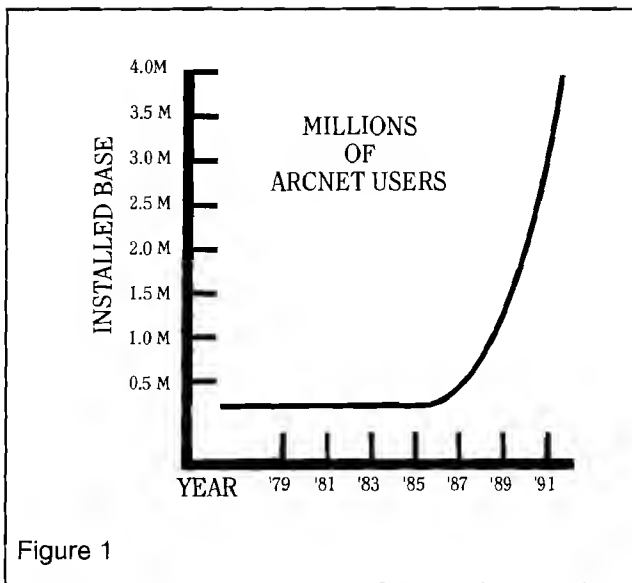

Figure 1

As a result of this concept, ARCNET has been driven by customer and commercial needs. With ARCNET, the customer has held the key in determining future enhancements. This has enabled suppliers to be more effective in terms of selling products. The resulting continuity and compatibility of products has provided a highly stable environment for ARCNET customers and resellers during the years of product evolution.

During the past three years, an increasing level of network bandwidth

requirements has emerged for many users in the ARCNET community. Network performance demands have also increased in certain application sectors, while they have remained constant or have even decreased in others. This conflicting level of requirements has led many previously satisfied ARCNET customers and resellers to seek higher performance networks as a general solution.

The high level of network integrity and flexible network expansion enjoyed by ARCNET users is certainly compromised through the incorporation of alternative network segments. Even in cases where wiring and network management has been mastered, the network performance achieved has been largely disappointing. To a great extent, this is due to the fact that even with its modest bit rate ARCNET has always provided users with a consistent and deterministic performance level over the full spectrum of commercial uses. (Figure 2)
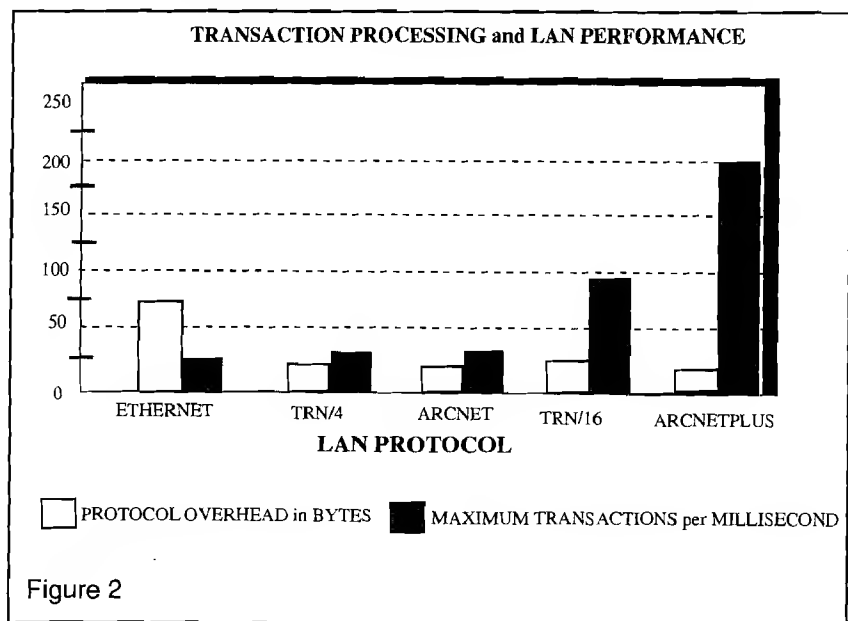

Figure 2

2

LAN Alternatives: Functional and Economic Implications

It may be helpful to consider some of the LAN alternatives to ARCNET and evaluate both their functional and economic implications.

Ethernet

The advent of 10BaseT wiring alternatives has significantly improved the appeal of Ethernet as an alternative to an existing ARCNET network. The ability to wire a facility in a star configuration for a higher degree of network management and troubleshooting capabilities, coupled with the dramatically reduced cost of PC adapters, has led many users to experiment with this technology in situations where network performance has become critical to user productivity.

The first negatives encountered in a wholesale replacement scenario are cable length limits (100 meters maximum) and configuration complexity (how many 10BaseT hubs can be added before active concentrators also must be added?).

The next concern involves measuring performance gains, especially as a cost differentiator between ARCNET and Ethernet. In small, simple networks, some gains are obvious. But in larger systems, the often forgotten implications of network packet collisions in transaction-based situations suddenly become quite real.

16 Mbps Token Ring Network

The IBM-sponsored 16 Mbps Token Ring Network (TRN) is an alternative that offers several attractive replacement benefits to a current ARCNET user. The wiring scheme — although it requires radically different and much shorter cables — is generally consistent with ARCNET's. And the even distribution of network bandwidth through the use of a logical token for packet transmission is accepted as a viable mechanism for a self-managed network.

In addition, TRN's 16 Mbps data rate, combined with a deterministic performance profile, can actually produce an improvement in raw network performance and help to justify the significant expense of the transition.

MIXING DIFFERENT NETWORK TECHNOLOGIES
MULTIPLE LAN APPROACH

PROBLEMS

- DIFFERENT, INCOMPATIBLE WIRING SCHEMES
- COMPLICATES MOVES AND CHANGES
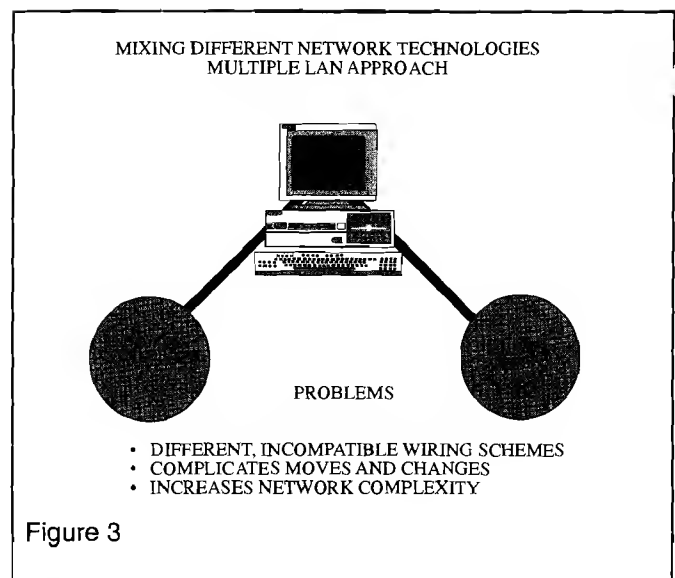- INCREASES NETWORK COMPLEXITY

Figure 3

From an economic standpoint, converting an existing ARCNET to either TRN/16 or 10BaseT Ethernet involves new expenses in four key areas:

- New PC adapter cards
- Replacement of hubs
- Network redesign
- Replacement of cabling plants

Partial Additions of TRN or Ethernet

Most real-world customer network performance problems are best resolved with a partial system change. Many ARCNET users are well served by the existing ARCNET LAN solution — parts have been purchased, wires are in place, training has been completed, and expenses have been absorbed. The needs of users whose productivity and application requirements demand and justify an increased level of LAN performance should be addressed individually. Both TRN/16 and Ethernet solutions have negative implications relative to a more "perfect" alternative.

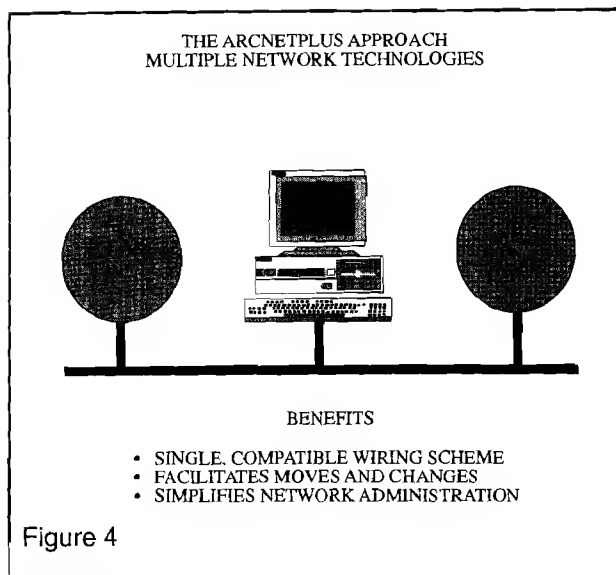The partial introduction of a new network topology into an existing LAN environment requires the use of several systems design techniques which drastically complicate network management and expansion. Network segments must somehow be bridged to allow continued access and sharing of common data and communications resources — the primary reasons networks exist. (Figure 3)

The complexity of systems configuration and the management implications of introducing multiple segments into a network must be factored into the overall equation as a cost. Both immediate and future costs related to restrictions such hybrid systems place into the planning cycle are important considerations for network systems administrators.

ARCNETPLUS: A Better Solution

ARCNETPLUS — the first multi-speed LAN — provides the performance benefits users demand, and retains ARCNET's topology characteristics. These benefits, which have been ARCNET's strengths for the past 15 years, are attained through the use of a single wiring scheme and allow upgrades to be made simply by making changes in the user's workstation. This separates the issues of building wiring and performance. (Figure 4)

THE ARCNETPLUS APPROACH
MULTIPLE NETWORK TECHNOLOGIES

BENEFITS
- SINGLE, COMPATIBLE WIRING SCHEME
- FACILITATES MOVES AND CHANGES
- SIMPLIFIES NETWORK ADMINISTRATION

Figure 4

ARCNETPLUS represents the implementation of five highly creative intellectual concepts, some of which are patented inventions, never before applied to the LAN environment. The first is the idea of a LAN with multiple, but interoperable capabilities. Simply put, this means the LAN exhibits multiple performance characteristics — higher data transfer rates when exchanging information between faster partners, and compatible lower data rates for exchanges between slower partners. The LAN's ability to identify and adapt the data transfer rates in a manner that is transparent to the upper-level operating systems and applications systems is a key to the commercial acceptance of such a product.

Beyond the multiple data rate functionality, there is another significant intellectual concept featured in ARCNETPLUS. It involves the capability of dynamically accomplishing data interchange determination supporting a wide variety of potential alternatives including:

- data rate and packet compatibility for both ARCNET and ARCNETPLUS nodes; and
- data rate with small packet support for ARCNETPLUS nodes.

Support of these alternatives creates a wide level of systems compatibility, including operation in existing networks without changing network operating system software. This significant capability results from the design of an interface directly into the ARCNETPLUS LAN Controller integrated circuit which provides compatibility for the original ARCNET software interface. This enables all software drivers written for ARCNET to be capable of immediate execution when coupled with a properly designed ARCNETPLUS network interface card.

Perhaps the most significant marketing implication of integrating ARCNETPLUS into an existing LAN environment is the ability to use existing star-based coaxial ARCNET wiring. This means ARCNET coaxial wiring rules are supported as a function of network design when ARCNETPLUS is implemented to enhance network performance. ARCNETPLUS is the only product set introduced for commercial use which allows use of 2,000-foot, copper wire network

segments at the node and wiring hub level.

ARCNETPLUS' analog design will enable future product enhancements to incorporate support for unshielded twisted pair and fiber optic interfaces, as is the case with the original ARCNET wiring scheme.

Another important intellectual aspect of the design and implementation of ARCNETPLUS is the multi-bit amplitude and phase modulated LAN transceiver. This allows for both wiring plant and signalling compatibility. (Figure 5)

The importance of characterizing ARCNETPLUS as intellectual property to both customers and resellers is twofold:

- System compatibility, as with the original ARCNET technology, can be facilitated by the establishment of a standard protected at the basic intellectual level whenever the term ARCNETPLUS is applied to any product in the marketplace.

ARCNET VS ARCNETPLUS

Figure 5
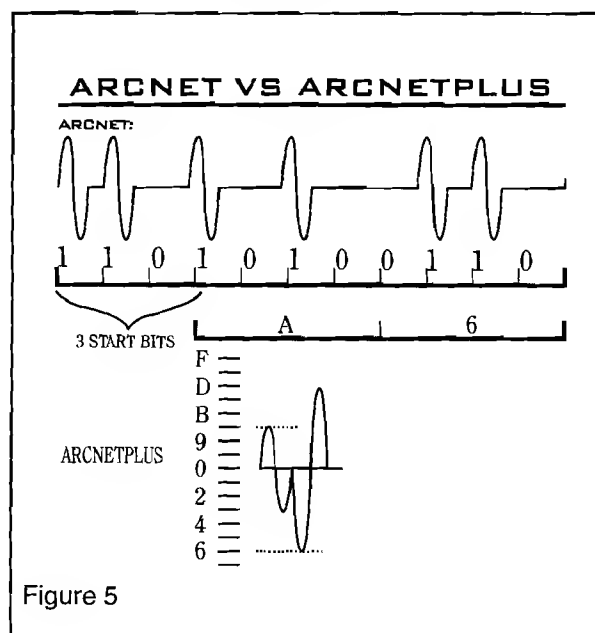
- Patenting the base technology allows Datapoint to offer the key ARCNETPLUS components and technology concepts to the general marketplace for improvements and enhancements vital to the evolution of network solutions in the PC, factory floor, process control, and other yet-to-be-explored environments.

Standardization

In today's marketplace, a major element in the design, sale, and acquisition of commodity technology is the support and development of standards.

As a de facto standard, ARCNET has been commercially successful for the past 15 years. But the absence of an accepted international standard designation has played a major role in the recent slowing of ARCNET's growth.

To address this situation, the ARCNET Trade Association — which was designated an American National Standards Institute (ANSI) standards development body in September 1991 — is chartered to have its ARCNET standard reviewed and approved by ANSI. ATA plans call for taking the same route to standardization for ARCNETPLUS. (Figure 6)

ANSI's confirmation of the ATA as a LAN standard development group — and a peer to IEEE — provides an appropriate alternative solution which allows both organizations to continue with their chartered activities. Conformance with the communications model established by the International Standards Organization (ISO) as
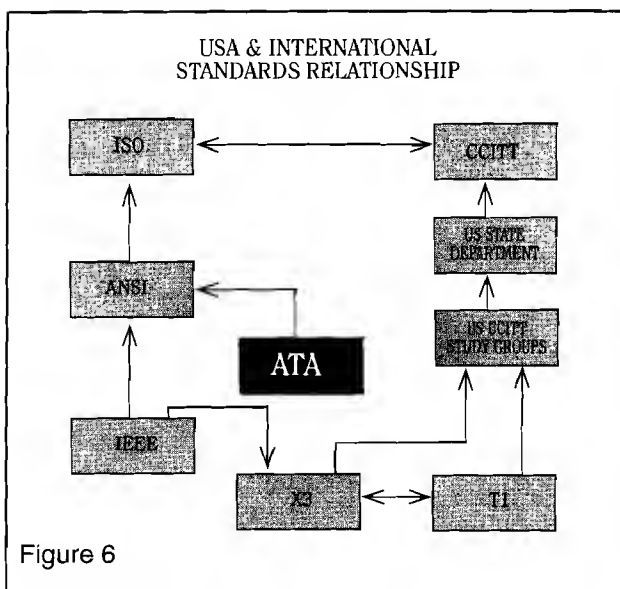

USA & INTERNATIONAL
STANDARDS RELATIONSHIP

Figure 6

the Open Systems Interconnect (OSI) model is the key to attaining an international standard designation. The OSI model shows the placement of ARCNET, ARCNETPLUS, and other formal and de facto LAN and WAN solutions based on this standard. (Figure 7) The primary consideration is compatibility with upper-level software and systems protocols which

can be achieved through any of the documented alternatives.

The proper placement of ARCNET — and now ARCNETPLUS — into this hierarchical structure has been delayed due to a lack of systems software solutions that exploit ARCNET at standard protocol levels. The only generic protocol which has been available for ARCNET in the past has been the IPX service module defined and implemented by Novell through its NetWare-supported network adapters. Recent developments have greatly extended this level of support to include the de facto standard Internet Protocol (IP). For the first time, this has enabled ARCNET users to gain access to application solutions based on the Transmission Control Protocol/Internet Protocol (TCP/IP) software standard.

LAYER		OSI PRODUCT	OTHER NORMS	OTHER LANS			FUNCTION
Application	7	X.400, X.500 FTAM	LU 6.2	NDS, Netware Lan Mgr, POWERLan 3COM, Vines Others	FTP		User application processing E-Mail, Networks, Directory Services
Presentation	6	X.226 X.216	3270 NCS VIDEOTEX			SMB	Syntax rules for messages definition
Session	5	X.225 X.215	SNA DNA				Service associated in starting and restarting a session
Transport	4	X.224 X.214	VTAM	SPX/IPX		NETBIOS	Point-to-point transmission
Network	3	X.25 451	SNA DNA		TCP/IP		Data transfer
Data Link	2	1431 HDLC	SDLC	IEEE 802.3 IEEE 802.4 IEEE 802.5 ARCNET ARCNETPLUS			Formatting data fields and address controls
Physical	1	1431, V24 X.21, RS232	FDDI				Physical and Electrical standards

Each of the seven layers in the OSI Model has a specific, independent function, but one which is logically linked to its closest neighbors. Services provided in this format offers a means of demonostrating the complexity of designing systems to accomplish information exchange and access.

Figure 7

In addition, a major change has occurred in the area of network hardware support, enhancing opportunities for both ARCNET and ARCNETPLUS to gain service access to present de facto standards and future formal connectivity standards. System software suppliers are now offering network adapter Packet Driver standards for public use. These products mask and make transparent the actual physical nature of both LANs and WANs in use in any specific customer systems solution. (Figure 8) Standard network adapter packet drivers include:

- the Open Driver Interface (ODI) from Novell;
- the Network Driver Interface Specification (NDIS) from Microsoft; and
- Clarkson Packet Driver from Clarkson University.

The implementation of these packet drivers throughout the industry will result in the availability of general service access to local and wide area network services — including transparent data packet interchange — through all network adapter technologies where these drivers have been incorporated. For the consumer, this trend represents the ability to mix and match diverse network segments selected according to a specific economic and systems architecture requirement based on the supported applications.

When this level of internetwork service is combined with the intranetwork functionality offered by the multi-speed LAN environment available with ARCNETPLUS, the real winner is the end user. Systems enhancements march in step with the evolutions in base LAN technologies that offer the most benefits in terms of flexibility and economy.

Environmental and Physical Considerations

Environmental and physical elements must also be considered when designing a customer LAN solution. These elements include:

- wiring distance limitations;
- electrical interference;
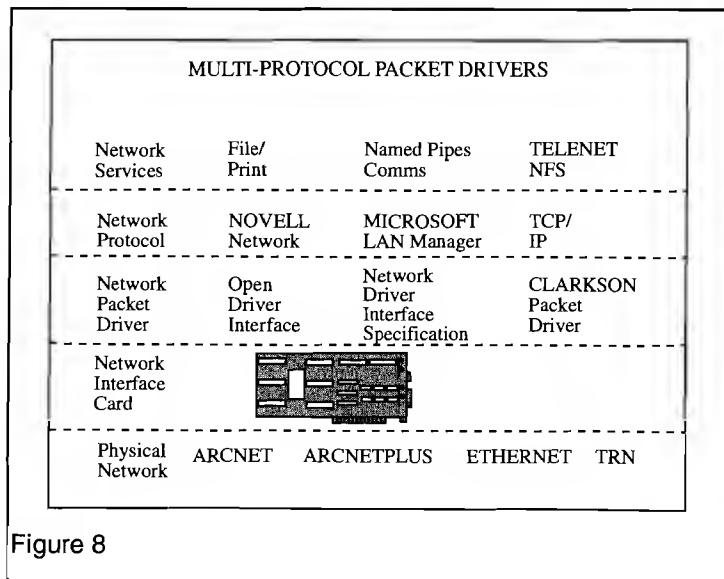- cost per linear foot;
- cost per connector;

- troubleshooting tools;
- multi-media support connectivity;
- standard protocol support, IPX, IP, Vines, Lan Manager, UNIX;
- connectivity; and
- gateway support, NETBIOS.

Before making any recommendation regarding a LAN performance upgrade to any customer, a competent systems analyst will first become comfortable with the customer's requirements and then determine an appropriate solution.

Making the Decision for ARCNETPLUS

The primary concept of a network is the provision for sharing business information in a way which is transparent to the individual user. The variety of requirements imposed on the networked system through the demands of the users creates a level of complications which tends to be inconsistent with the geography of the typical business environment. Network decisions therefore have to accommodate the mechanical requirements for long range planning and the individual requirements for varying levels of applications performance.

Into this complex equation comes ARCNETPLUS, which for the first time enables a purchasing decision for the LAN to incorporate multiple levels of performance within a single systems wiring scheme. Comparisons of price and performance become issues to be resolved at each user level as opposed to becoming issues which have to be imposed on the entire network due to the higher performance requirements of a few specific users.

Figure 8

MULTI-PROTOCOL PACKET DRIVERS

Network Services	File/ Print	Named Pipes Comms	TELENET NFS
Network Protocol	NOVELL Network	MICROSOFT LAN Manager	TCP/ IP
Network Packet Driver	Open Driver Interface	Network Driver Interface Specification	CLARKSON Packet Driver
Network Interface Card			
Physical Network	ARCNET	ARCNETPLUS	ETHERNET TRN

Selecting a high performance network solution for a specific set of users can now be placed into the same category as the selection of color screens, local disks, increased memory, or higher performance CPUs. In each of these cases, the management decision to acquire high performance is based on the individual needs of the users and their contribution to the goals of the total organization. Now, for the first time, the same concept has been extended to the LAN. Installation of a common wiring scheme, coupled with a high performance ARCNETPLUS LAN Adapter in the server, provides a multi-speed LAN environment. As user application requirements demand higher performance network service, individual purchasing decisions can be made in the same way as other high performance add-ons to the computing environment.

ARCNETPLUS

Based on ARCNET, the world's first commercially-available LAN technology, ARCNETPLUS truly offers a sensible alternative to the other LAN technologies available in the marketplace. ARCNETPLUS has been designed to meet the latest in application requirements — database, image, graphics, and windowing services — and with its unique multi-speed performance capability, offers far more than simply the best alternative LAN solution.

ARCNETPLUS, combined with existing ARCNET technology, offers a unique, price-competitive solution to the problems posed by today's multi-functional network components.

ARCNETPLUS offers existing ARCNET users a unique opportunity to test and evaluate high-performance networking in a production environment — the Test Drive[SM]. Since the ARCNETPLUS components are one-hundred percent compatible with existing ARCNET installations, a user can assess their purchase requirements by simply installing ARCNETPLUS into key network nodes and exercising their applications in a production networking environment. The simplicity of the ARCNETPLUS upgrade combined with the Test Drive capability make ARCNETPLUS the first LAN to evolve beyonds its roots in the world of high performance networking.